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## THE LARVAL EYE OF CHITONS.

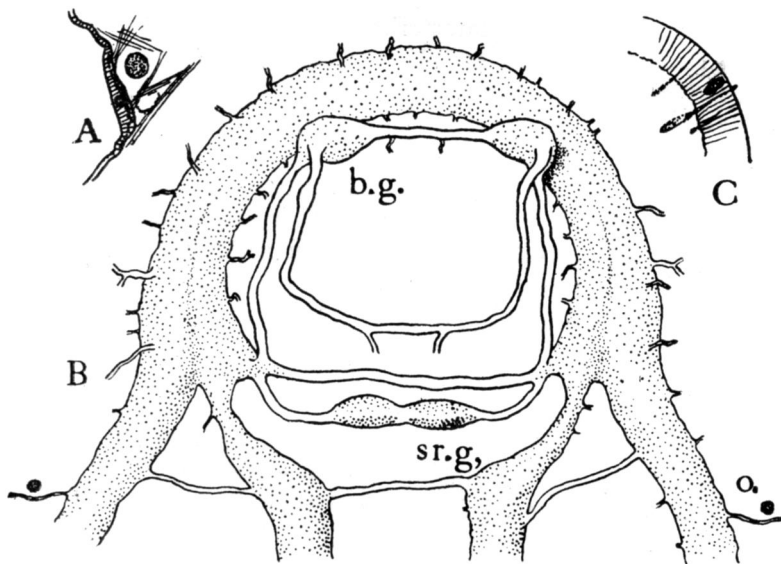
BY HAROLD HEATH.

In *Chiton polii*, according to Kowalevski, and in *Ischnochiton magdalenensis*, *Trachydermon raymondi* and *Nuttallina thomasi* the eyes of the larvæ become clearly defined about the time of the first appearance of the shell. They are situated immediately behind the velum, half-way up the sides of the body. Concerning their structure Kowalevski writes,<sup>1</sup> "They are characterized by the pigment deposited about a central clear body, and are placed almost entirely upon the lateral or branchial nerves." As the figures of this author show, each ocellus at this time consists of a single cell imbedded in the epithelium covering the body. In later stages this condition of affairs in the young of *Chiton polii* becomes more complex. According to Kowalevski, the pigmented body, with its clear included vesicle, retains its early characters, but migrates "under the skin and upon the branchial nerve. The ectodermic epithelium, situated above the eyes, presents certain modifications which may be related to the function of the ocellus; its cells are here very slender, more elongated than those adjoining, their appearance is different, and it appears to me possible that these cells play a certain rôle in the transmission of luminous rays to the ocellus and perform the function of a cornea."

While working upon certain problems connected with the larval development of chitons, I have many times noticed the ocelli in several species. In those forms enumerated above, save *Chiton polii*, I have traced these structures through all stages, from their first development until their final disappearance; and after the metamorphosis of the larva have determined their fate in *Ischnochiton mertensii*, *I. regularis*, *I. cooperi*, *Katharina tunicata* and *Tonicella lineata*. In its early stages in these species each eye appears essentially as described by Kowalevski, and this state of affairs continues as long as the ocellus may be distinguished. Under no circumstances does it become subepithelial. In many cases the pigmented cell sinks somewhat beneath the general outer surface of the epithelium and is partially over-arched by neighboring cells, but these are in no wise different from those elsewhere in the skin and never give the impression of forming

<sup>1</sup> "Embryogénie du *Chiton polii* (Philippi) avec quelques remarques sur le développement des autres Chitons," *Ann. Mus. hist. nat. Marseille*, T. I, No. 5.

a lens or cornea. There is no reason to doubt the correctness of Kowalevski's observations, but the eye of *Chiton polii* is certainly not typical. On the other hand, the eyes of the chitons I have examined are in their histological details essentially like those of the annelid trochophore. In the latter organism they are placed in the velar field and are innervated by nerves from the cerebral ganglia; in the chitons they are posttrochal and are situated on the pallial cords. These facts, however, may not be fatal to the theory that the ocelli of the larvæ of these two phyla are homologous, especially in view of the fact that their early development is almost identical. I have shown in another paper<sup>2</sup>



A. Section through ocellus and pallial cord of sexually mature *Trachydermon raymondi* (6 mm. long). B. Anterior part of nervous system of *Ischnochiton mertensii* (4 mm. long); b.g., buccal ganglion; sr.g., subradular ganglia; o., ocellus. C. Section through eye-spot of annelid (*Sabella*) trochophore.

that the head vesicle, or the part of the chiton larva anterior to the velum, "becomes transformed into part of the first valve of the shell, the mantle and mantle furrow of the same region, and into the proboscis." Now it is obvious that if the chiton eye were situated in front of the velum, as in the annelids, it would be most unfavorably placed after the metamorphosis. Under the circumstances the most available situation would be the furrow about the proboscis, where it

<sup>2</sup> "The Development of Ischnochiton," *Zool. Jahrb.*, Bd. XII, 1899, p. 630.

would be continually obscured and would be practically useless even if provided with special tentacles. It seems most reasonable to suppose that as the structures characteristic of the chitons appeared in the phylogenetic development, the eye-spots gradually shifted their position into the present more favorable location.

Pelseneer<sup>3</sup> has made a detailed study of the larval eyes of some of the *Mytilidæ* and the related genus *Avicula*. They arise in the embryo behind the velum and on the base of the first gill-filament. "Each eye is open, that is to say, an invagination of the skin, and consists of pigmented epithelial cells. . . . The cavity is filled by an elongated crystalline body continuous with the overlying cuticle. . . . They have a structure intermediate between the eyes of *Patella* and *Trochus*," and are innervated by fibers from the cerebral ganglia. Pelseneer considers that this type of eye and that of the chitons are homologous. This assumption must rest entirely upon the fact that both are post-trochal. They certainly are fundamentally different in structure. Even with *Chiton polii* this is the case, and, furthermore, this organ in the lamellibranchs is innervated by nerves from the cerebral ganglia, and in the chitons by the pallial nerves. Thiele's<sup>4</sup> contention that the eye of *Arca noæ* and the chiton eye are homologous rests upon the same foundation as Pelseneer's argument. Both are behind the velum, but fundamentally different structurally and in their innervation. As the matter now stands, the theory that the chiton and the annelid eye are homologous rests upon identity of structure; while the chiton and lamellibranch larval eye are supposed to be genetically related because of similarity of position.

It is improbable that the eyes of chitons are functional only in the larvæ. In the three species studied before the metamorphosis the pigment appears about twenty-four hours prior to the free-swimming stage, which lasts from fifteen minutes to twenty-four hours, according to conditions. After the metamorphosis, which ensues after the embryos have settled, these sense organs in at least eight species invariably persist for a considerable length of time. In fact, they appear to remain as long as the shell and mantle are sufficiently transparent to allow the light to penetrate, or until the animal is upward of 5 mm. in length. Some of the smaller species are at this time sexually mature; while some of the larger forms are only one-fourth or even one-tenth their adult size.

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<sup>3</sup> "Les yeux céphaliques chez les Lamellibranches," *Arch. de Biol.*, T. 16.

<sup>4</sup> "Ueber Sinnesorgane der Seitenlinie und das Nervensystem von Mollusken," *Zeit. f. w. Zool.*, Bd. XLIX.